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Vol. 39 No. 3

BULLETIN

OF THE

TORREY BOTANICAL CLUB

MARCH 1912

Violet hybrids between species of the palmata group

EZRA BRAINERD

(WITH PLATES 5–7)

In my last paper on violet hybrids, published over six years ago, and in the one preceding it,* I described only one hybrid whose parents were both in the natural group represented by *Viola palmata*. I recognized the fact, however, that these closely allied species seemed "to be confluent when growing together," and stated my belief that "they can and do interbreed." It has been often observed that natural hybrids between doubtfully distinct species, or between a species and its variety, are the most difficult to determine with certainty; the less remote from each other the two species that hybridize, the less marked and less numerous are the signs of hybridity in the offspring. For six seasons now, I have had many suspicious intermediates of this group under cultivation, raising sometimes a hundred or more offspring from one plant, extending through three or four generations. Some of the results of these experimental cultures, I trust, will prove of interest to students both of systematic botany and of heredity.

VIOLA PALMATA × PAPILIONACEA Brainerd.†

Leaves cordate-ovate as in *V. papilionacea*, lobed after the manner of *V. palmata*, but less deeply so; the capsules from cleistog-

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* Rhodora 6: 213–223. N 1904; and Rhodora 8: 49–60. Mr 1906.

† Dowell, Ph. The violets of Staten Island. Bull. Torrey Club **37**: 177. Ap 1910. At least one of the specimens there cited (*4777*), Dr. Dowell would now call *V. papilionacea* × *triloba*.

[The BULLETIN for February 1912 (**39**: 37–84. *pl. 1–4*) was issued 9 Mr 1912.]

amous flowers ovoid-conical, 5–7 mm. long, or half as long as the normal capsule in either parent, containing in the 48 capsules examined an average of 4½ seeds to the capsule. (PLATE 5, *Aa.*)

In June 1906 Mr. W. DeWitte Miller sent me from Plainfield, N. J., a plant that he considered this hybrid. Three years after transplanting, the rootstock was much branched and 8–10 inches broad; in the spring of 1909 part of it was broken up and ten new plants obtained, which in a year or two became so luxuriant that half of them were purposely destroyed. From the original plant 23 offspring have been raised. Of these, 6 had deeply lobed leaves like those of *V. palmata;* 4 had uncut leaves like those of *V. papilionacea;* and the remaining 13 had leaves somewhat lobed as in the hybrid. (See PLATE 6.) In 1909 numerous offspring were raised from 8 of the above 23 plants, with the following results: (1) The seedlings from a plant with uncut leaves (in one instance 18) had always uncut leaves like the parent. (2) The seedlings from a plant with deeply cut leaves (in one instance 19) had always deeply cut leaves like the parent. (3) The seedlings of plants with leaves somewhat lobed as in the original hybrid, in the five instances tested, always gave plants of the three forms given by the original hybrid. In more technical language, the form of the hybrid leaf displays no dominance of the form of either parent but is a compromise between the two forms. But when plants having this hybrid form of leaf reproduce, the offspring present variously the two extreme forms of the original species and the compromise form of the hybrid, in this conforming to the Mendelian law of 'segregation.'

There is also approximate conformity to the Mendelian ratio of 1:1:2 in the number of each of the three kinds of offspring. The total progeny raised from plants having the hybrid form of leaf was 49; of these, 13 had deeply cut leaves (form *A*); 12 had uncut leaves (form *a*); and 24 had the compromise leaf (form *Aa*). This is as near to the above ratio as is practically possible with a total of 49 plants.* The further Mendelian principle is illustrated: that when an offspring of a hybrid reverts to a pure character of either parent species, that character continues pure in succeeding generations if the plant is self-fertilized. In this particular hybrid, when the leaf form of *V. papilionacea* once reappears, it is kept up in the subsequent progeny; so, when the leaf form of *V. palmata* once comes back, it comes to stay.

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* The theoretical ratio 12¼ : 12¼ : 24½ cannot be concretely realized, as the number of each kind of hybrid forms must necessarily be a whole number.

Another instance of a cross between *V. palmata* and *V. papilionacea* was found among several plants of *V. palmata* from Orange, N. J., exhibited by Miss Angell at the "violet symposium" at Bronx Park, May 1905. The plants were later set out in the New York Botanical Garden. On examining them the following September, my attention was called to a stocky plant with leaves wider and less deeply lobed than the rest; cleistogamous flowers were abundant, but their capsules were nearly sterile. From the few ripe seeds obtained, plants were propagated for three generations, with results quite the same as in the hybrid from Plainfield.

In the autumn of 1906 I received from Miss A. M. Ryan of New London, Conn., fresh leaves and a few ripe seeds of a plant collected by Miss Pauline Kaufman in the vicinity of New York City. The leaves were quite the same as those of Mr. Miller's hybrid. Two plants only were raised from the seeds sent; but later, a brood of offspring from each of these. The first brood (sowing 320) consisted of nine heterogeneous plants, proving the hybrid nature of the mother, as well as of the plant collected by Miss Kaufman. Of the second brood (sowing 592) eight plants were raised, all with deeply lobed leaves like the mother, and hardly distinguishable from normal *V. palmata* except by smaller capsules and greatly impaired fertility.

I have said nothing as yet of the inheritance in these hybrids of pubescence from *V. palmata*, or of the lack of it from *V. papilionacea;* this, however, was quite similar to the inheritance of lobation, or the lack of it, though not as conspicuous. The most interesting circumstance was that frequently the lobed leaves and the pubescence of *V. palmata* were not both inherited by the same offspring. A seedling with lobed leaves would often be glabrous; and on the other hand, one with uncut leaves would often be pubescent and might have easily passed for *V. sororia* except for its infertility.

Such aberrant forms occasionally appear in the wild. In May 1909 I saw some excellent photographs taken by Miss E. M. Kittredge of certain anomalous violets found near her home in

Spring Valley, N. Y. One showed plainly a glabrous specimen of *V. palmata* in flower. By the kindness of Miss Kittredge the live plant was presented to me in June. On collecting close-fertilized seeds the following August, I found on the average 16 seeds to the capsule; that is, about three fourths of the ovules were undeveloped. Among the offspring raised the following season, were plants representing not only the deeply lobed leaves of *V. palmata* but also the uncut leaves of *V. papilionacea.* Both forms, however, were glabrous, as was to be expected; for a dominant character like pubescence, when once lost, never reappears. Nevertheless, the hybrid origin of the wild plant was clearly established. Let me cite one further instance.

On April 15, 1909, I found at Tryon, N. C., what seemed to be a colony of this glabrous *V. palmata.* In the vicinity grew both the normal hairy *V. palmata* and the glabrous *V. papilionacea.* Of the anomalous plants six with leaves moderately lobed were shipped to Vermont to be grown and studied in the garden. All proved to be more or less infertile, averaging about 20 seeds to the capsule. Offspring were raised from all six; and in each brood but one were to be seen plants with uncut leaves, indicating that one parent of the original hybrid was *V. papilionacea;* from which, doubtless, was also inherited the glabrous character of the plants at Tryon.

Viola palmata × triloba hyb. nov.

First 1–3 leaves of spring often uncut as in *V. triloba*, followed by others more or less 5–7-lobed, much like those of *V. palmata* but the basal lobes broadly dilated and coarsely toothed as in *V. triloba;* later leaves less dissected, mostly 3-lobed or obscurely lobed; capsules infertile, about one third of the ovules maturing into seeds; offspring multiform, often bearing on the middle segment of the trilobed leaves 4–8 undulations or coarse teeth.

The genuine *V. Angellae* Pollard (Torreya 2: 24. 1902), proves to be this hybrid, as the original description and the type sheet of mature plants (U. S. National Herbarium no. 352,093) clearly show. One of the flowering plants on sheet no. 364,862 may, however, be pure *V. palmata.* It would seem that the original collection by Miss Angell, June 1899, contained many specimens of *V. palmata*, as some of them are to be seen mounted in the National Herbarium, and others were distributed only last summer with the name "*V. Angellae*" on the printed labels. Possibly some of these plants may be imperfect reversions to *V. palmata*. Furthermore, as already stated, most of the specimens of "*V. Angellae*" exhibited at Bronx Park May 1905 were *V. palmata*. Others also have erroneously assumed that plants that they collected at the type station were therefore typical *V. Angellae*. Mr. Pollard distinctly states that his new species is associated with *V. palmata* in the Orange Mountains.

In May 1908 Dr. E. L. Greene kindly sent me a dozen plants of his *V. variabilis* from the type station, opposite Harpers Ferry and named by him Maryland Heights. Most of these plants have since been growing in the garden, and from some of them have been raised two generations of offspring. These plants I make out to consist of two different hybrids of *V. triloba*, one being the *V. palmata* × *triloba* above described. A close comparison of the characteristic leaf of this hybrid (PLATE 7, FIG. 3 and 4) with the leaves of the supposed parents (FIG. 1 and 2) will disclose its compromise outline. The leaves of Dr. Greene's plant, though at first suggesting *V. palmata*, differ in having the broad basal lobes of *V. triloba* even as early as May 31; while specimens collected July 22 and September 16 display leaves decidedly trilobed, and some hardly lobed at all. This tendency towards uncut leaves in autumn is characteristic of *V. triloba* but not of *V. palmata*. Furthermore, in some of the segregating offspring (PLATE 7, FIG. 5 and 7) may we not see in the oddly shaped middle segment the resultant of opposite impulses, one demanding 9–11 lobes, the other forbidding more than 3?

So much for the evidence from the living plant, cultivated for four seasons and through three generations. The conclusion drawn from this experiment is well sustained by a careful study of the seven sheets of "*V. variabilis*" at the National Museum. Four were collected May 14, 1898—two by Dr. Greene, and two by Mr. Pollard, who accompanied him—and three others by Dr. Greene May 10, 1903; all from Maryland Heights opposite Harpers Ferry. The 17 plants here mounted I regard as a medley of at least five distinct forms, three of which are represented in the live plants sent in 1908. I shall here speak of only the palmatifid form, which Dr. Greene says "is exceedingly similar to Mr. Pollard's recently proposed *V. Angellae*, indeed so much like it that I have little if any doubt they are one, specifically."* In this I agree with Dr. Greene; and in both cases plants of pure *V. palmata* were collected with the hybrid *V. palmata* × *triloba*, three of the former and four of the latter appearing among the 17 mounted specimens labeled by Dr. Greene *V. variabilis*. One of each kind is to be seen on U. S. National Herbarium sheet no. 328,245, collected by Mr. Pollard and labeled by him in pencil "*V. palmata*."

A plant distributed by Mr. Witmer Stone, as *V. palmata variabilis* (Greene),† seems to be, at least in part, the hybrid under discussion. I have observed also several other specimens that appear to be this; but one may not with confidence identify a hybrid between two species so closely allied without abundant material or the data obtained by experimental cultures.

Viola papilionacea × triloba hyb. nov.

Leaves of late spring and summer shallowly, often obscurely, 3–5-lobed, uncut leaves subcordate, often broadly reniform; capsules even from cleistogamous flowers infertile; offspring inheriting diversely the opposed characters of the parent species.

My first acquaintance with this hybrid was through some anomalous living plants sent from Washington, D. C., in May 1906, by Mr. E. S. Steele, along with samples of pure *V. triloba*. The six plants of the latter were quite alike—pubescent, cut-leaved, buff-seeded, fertile, and easily separated by the purple tinge of the early spring foliage from the anomalous plants. These were of three forms: (1) One plant fairly fertile, with pubescent uncut leaves as in *V. sororia* but bearing buff seeds. (2) Two plants fairly fertile, with uncut leaves and dark brown seeds as in *V. papilionacea* but pubescent. (3) One plant nearly sterile, averaging 6½ brown seeds to a capsule, the leaves glabrous and somewhat 3-lobed. Offspring were raised from all of these: those from (1) and (2), 6 plants from each, seemed to be stable, that is, in each instance all had characters like those of the mother; the offspring from (3) were only two, one with uncut leaves, one with 3-lobed leaves.

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* Pittonia 5: 91. 1902.

† No. *5111*, colony 5, Argus, Pa., June 8, 1903, Dr. C. D. Fretz.

The problem is to account for the presence in a colony of normal *V. triloba* of three plants so variant from *V. triloba* and from each other. But however confused the situation may appear, all may be accounted for by regarding the three odd plants as the descendants of a cross between *V. triloba* and *V. papilionacea*, a common species of the region. Plant (1) seems to have escaped the conflict of characters forced into the make-up of the original hybrid and attained to stability and relative fertility, inheriting uncut leaves from *V. papilionacea* but pubescence and buff seeds from *V. triloba*. Plant (2) seems to be another stable ex-hybrid, inheriting also pubescence from *V. triloba* but dark brown seeds as well as uncut leaves from *V. papilionacea*. Plant (3) is partly rescued from hybrid instability, at least as regards pubescence, but is still hybrid as regards leaf form — what we may call a subhybrid, still bearing in its infertility the stigma of its irregular parentage.

Of the twelve plants of "*V. variabilis*" sent me by Dr. Greene in 1908 I regard nine as the progeny of *V. papilionacea* × *triloba;* and the case is exactly parallel to the one just described, though on a somewhat larger scale. The differing characters of Dr. Greene's plants are presented in the following synopsis, and will be found in all cases to be only new combinations of those found in the putative parents. The numbers given are those that the several plants bear in my notebook.

- Leaves with uncut blades.
  - Blades broadly cordate-ovate, blunt-pointed, pubescent beneath.
    - Seeds buff, about 11 in a capsule 2, 12
    - Seeds dark brown, about 14½ in a capsule 5, 6, 7, 10
  - Blades much dilated, subglabrous; seeds brown 4
- Leaves slightly lobed in spring, later leaves uncut, broadly reniform, truncate or subcordate; seeds brown 9
- Leaves 3–5-lobed, subglabrous; seeds brown 8

On the seven sheets of "*V. variabilis*" in the U. S. National Herbarium there are only six plants that represent this group, and they all have uncut leaves. As none were collected later than May 14, the color of their seeds is unknown; nor has any plant developed leaves with subcordate reniform outline. These forms and the two with lobed leaves (no. 4, 9, and 8 above) indicate that Dr. Greene sent me a fuller representation of this hybrid group than he had previously collected for himself.

Dr. Greene's conception of a species, which without hybridizing appears "under forms enough to make three," is quite contrary to the latest inductions of biology. The law that "like produces like," even through seed (when pure or not affected by foreign pollen), is confirmed by numerous experimental tests. If we except the extremely rare cases of observed mutation, the offspring of a species or of a natural variety is always uniform.* Whenever a miscellaneous offspring appears, we may be confident that at no very remote past, species or varieties, as unlike or more unlike than the offspring, were sexually united in the parentage.†

Several other examples of *V. papilionacea* × *triloba* might be cited, but I name only two from well known collections: No. 34, North American Violaceae, Greene and Pollard; "*V. palmata dilatata* Ell." New Springville, Richmond Borough, N. Y., Wm. T. Davis, July 17, 1903; also no. *5108*, colony 3, Violets of Philadelphia and vicinity; "*V. palmata dilatata* Ell." Sherwood, Pa., June 17, 1903.

Viola sororia × triloba hyb. nov.

The confluence of these two species is generally recognized, and it is so common that many students of *Viola* have regarded them as forms of the same species; just as, because of a similar confluence, *V. sagittata* has been held to include *V. fimbriatula.* The shallow and obscure lobes of the hybrid leaf are the same as in *V. papilionacea* × *triloba*, but the foliage is never glabrous. But more satisfactory than this negative test is the discovery of the intermediate forms in a region from which *V. papilionacea* is absent. Along a shady limestone ledge in Orwell, Vt., where *V. triloba* and *V. sororia* were abundant, but no *V. papilionacea*, was found in 1904 a large colony of intermediates that will pass muster as *V. sororia* × *triloba*. In this case the most satisfactory evidence would come from the artificial production of the hybrid; this I trust will soon be attempted.

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* Dimorphism, such as the constant reproduction of both staminate and pistillate plants, or of long-styled and short-styled forms, belongs to another class of phenomena.

† See DeVries, H. Species and varieties. Lectures 6 & 7, on stability and vicinism.

It may be noted that the leaf outline in *V. triloba* is relatively broader and less deeply cordate than in *V. sororia* (or in *V. papilionacea*), and that the hybrid offspring may inherit the uncut leaves of the latter and the broad outline of the former, thus presenting a decidedly reniform leaf. Such stable forms often emerge in experimental cultures and are occasionally met with in the wild near stations for *V. triloba.* I have usually found such broad-leaved specimens of "*V. sororia*" to be infertile. It seems to be this that Dr. Greene has named *V. populifolia.* (Pittonia 3: 337. S 1898.)

The two hybrids of *V. Stoneana* that follow are analogous to the two last described.*

Viola papilionacea × Stoneana hyb. nov.

Glabrous; first one or two leaves uncut, succeeded by larger ones 5–7-lobed; the middle segment broad, the basal lunate coarsely serrate, the lateral but slightly if at all narrowed at the base; autumn leaves often much dilated and obscurely lobed; capsules more or less infertile, 7–12 mm. long; offspring diversiform as to lobation.

A plant of this was taken from Ivy Hill Cemetery, Philadelphia, September 1905. From close-fertilized seed collected and sown in the autumn of 1906 were grown the following season, plants that had three distinct leaf forms: (1) the uncut leaf of *V. papilionacea;* (2) the 5-parted leaf of *V. Stoneana* with segments much narrowed toward the base; (3) the 5-lobed leaf of the original plant. From six of these plants a third generation was grown in 1909, in which all from (1) and (2) were homophyllous, and those from (3) heterophyllous, as in the brood obtained in 1907. From (1) a fourth generation was raised in 1910, all like the parent.

Viola Stoneana × triloba hyb. nov.

Leaves 5-lobed; lower surface and petioles somewhat pubescent; capsules infertile; seeds buff; offspring in part glabrous, in part quite pubescent.

The original plant was collected at Ivy Hill Cemetery, Philadelphia, in 1905, with the one last described. Four seedlings were grown in 1907: one quite glabrous, in this reverting to *V. Stoneana;* the other three more or less pubescent. From each of the four plants offspring were obtained in 1909. Those from the glabrous plant were also all glabrous; two of the pubescent plants bore both pubescent and glabrous offspring; the remaining pubescent plant bore nine offspring, all pubescent, thus indicating that in this instance the pubescence of the mother plant was a stable character. This happens to be exactly the relative number of these three forms of offspring required, on the average, by the laws of Mendel.

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* Cf. The evolution of new forms in *Viola* through hybridization. Am. Naturalist 44: 231. Ap 1910.

Viola latiuscula × triloba hyb. nov.

Leaves moderately 3–5-lobed, sparsely pubescent on the petioles and veins of the young leaves; capsules about 8 mm. long, maturing 10 or 12 brown seeds; progeny heterogeneous.

For my acquaintance with this hybrid I am indebted to the discernment and diligence of Mr. B. H. Slavin of the Park Department of the City of Rochester, N. Y. On June 19, 1909, he sent me from Salamanca, N. Y., six odd-looking plants, all glabrous; four with leaves somewhat lobed, subcordate-ovate, blunt-pointed; two with leaves uncut. As they flowered and matured the following season, I detected certain marks of *V. latiuscula:* a crimson tinge in the early spring foliage, and a granular roughness along the upper edges of the petiole. At my request Mr. Slavin revisited the station for further collections July 6, 1910, and sent me in the autumn an excellent suite of the various forms to be seen in that colony. For a better apprehension of their relation to each other, I borrow some of the symbolism of Mendel. For brevity he uses letters instead of phrases, somewhat in this fashion:

Let A = cut-leaved
" a = with leaves uncut
" Aa = with leaves somewhat uncut

Let B = pubescent
" b = glabrous
" Bb = somewhat pubescent

All of these six characters are found in the above described hybrid or in the parent species; in the offspring of the hybrid they should be redistributed in all possible combinations. It is evident that each one of the three characters in the first group may combine with each of the three in the second group, making in all nine different combinations. These are given in the following table, the asterisk after any form denoting its occurrence at the Salamanca station.

1	A	B	*	Reversion to typical *V. triloba*.
2		b	*	New and stable form, glabrous *V. triloba*.
3		Bb	*	Cut-leaved form, hybrid as respects pubescence.
4	a	B	*	New and stable form, pubescent *V. latiuscula*.
5		b	*	Reversion to typical *V. latiuscula*.
6		Bb		
7	Aa	B	*	Pubescent form, hybrid as respects lobation.
8		b	*	Glabrous form, hybrid as respects lobation.
9		Bb	*	Dihybrid, *V. latiuscula* × *triloba*.

The one form lacking should be a somewhat pubescent plant with uncut leaves. The proof that we have here a colony of *V. latiuscula* × *triloba* will be convincing to one familiar with the behavior of hybrids.

Three hybrids of *V. hirsutula*, one with each of our three cut-leaved species, call for a few brief comments.

Viola hirsutula × triloba nom. nov.

V. palmata × *villosa* Brainerd, Rhodora **8**: 56. Mr 1906. Cf. House, H. D. Violets of the District of Columbia, Rhodora **8**: 121. Jl 1906. The former name of each parent species has proved to be untenable.*

This beautiful and easily recognized hybrid is of frequent occurrence from northern New Jersey to the mountains of North Carolina and eastern Tennessee. A most interesting colony, of a hundred or more plants, was found at Morristown, Tenn., on a tract of woodland recently cleared and worked to be made an addition to a cemetery. The plants were reverting in various ways to the characters of one or the other of the original parents. Some were large in size, others small; some had lobed leaves, others not; most had both the silvery pubescence of *V. hirsutula* on the upper surface of the leaf and the villous pubescence of *V. triloba* on the lower surface of the leaf, but occasionally one or the other form of pubescence was nearly or quite lacking. Not only from these, but from a plant sent me October 1907 from Orange, N. J., by Miss A. M. Ryan, I have raised unlike offspring, some with uncut leaves, some with leaves mostly lobed. In Mr.

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* See Rhodora **9**: 96–98. Je 1907; and Bull. Torrey Club **37**: 584–587. D 1910.

Witmer Stone's Violet Distribution no. *5107*, colony 3, "*V. palmata dilatata* Ell.," Sherwood, Philadelphia, May 17, 1903, is plainly this hybrid. So also is *H. D. House 823*, Glen Echo, May 25, 1905, Violets of the District of Columbia. The name on the label, "*V. villosa* × *palmata asarifolia*" would indicate that Mr. House considered it *V. hirsutula* × *sororia;* but my specimen bears one *lobed* leaf.

Viloa hirsutula × palmata hyb. nov.

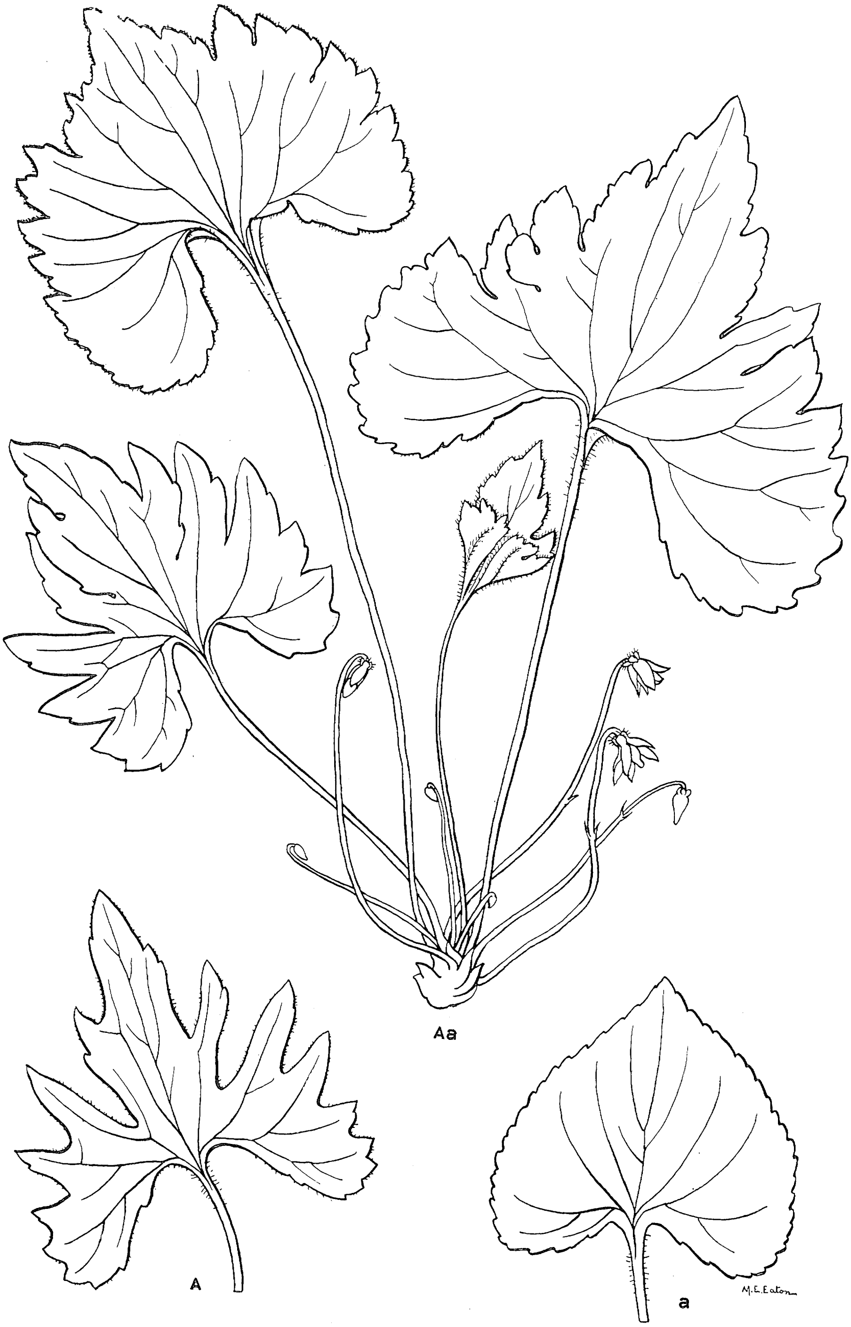
Plant small, cespitose; leaves all palmatifid, the incisions becoming shorter toward the base; the blades somewhat pubescent beneath, finely ciliate and bearing minute white hairs along the veins above; capsules nearly sterile.

One plant only was found in an open woods near Plainfield, N. J., September 1906, with both parents growing near. This was transplanted to the Middlebury garden and later multiplied by division, but I have failed to obtain sufficient seeds for a sowing. However, the marks of its double parentage are pronounced.

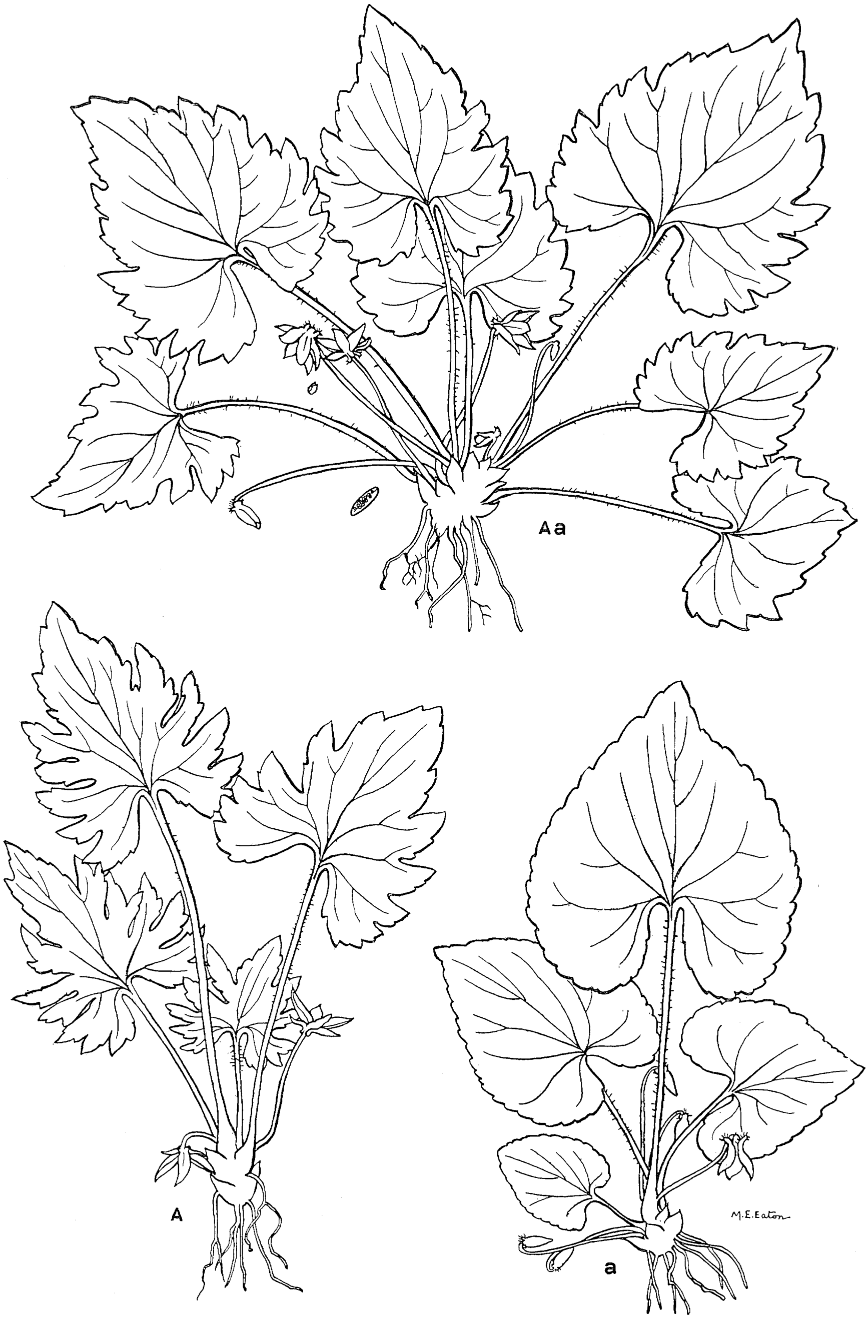
Viola hirsutula × Stoneana nom. nov.

V. Stoneana × *villosa* House, Rhodora **8**: 121. *pl. 72.*, Jl 1906. The plants seem to be rare; Mr. House got it only from the type station, Hyattsville, Md. I collected a specimen at Ivy Hill Cemetery, Philadelphia, Sept. 6, 1905; and in April 1908 Dr. Theo. Holm kindly sent me a live plant from Brookland, D. C. From the latter plant I obtained in 1909 three offspring that differed widely from each other in the relative number of cut and uncut leaves, and in that the cut leaves of the several plants were quite unlike each other in the number and length of the lobes.

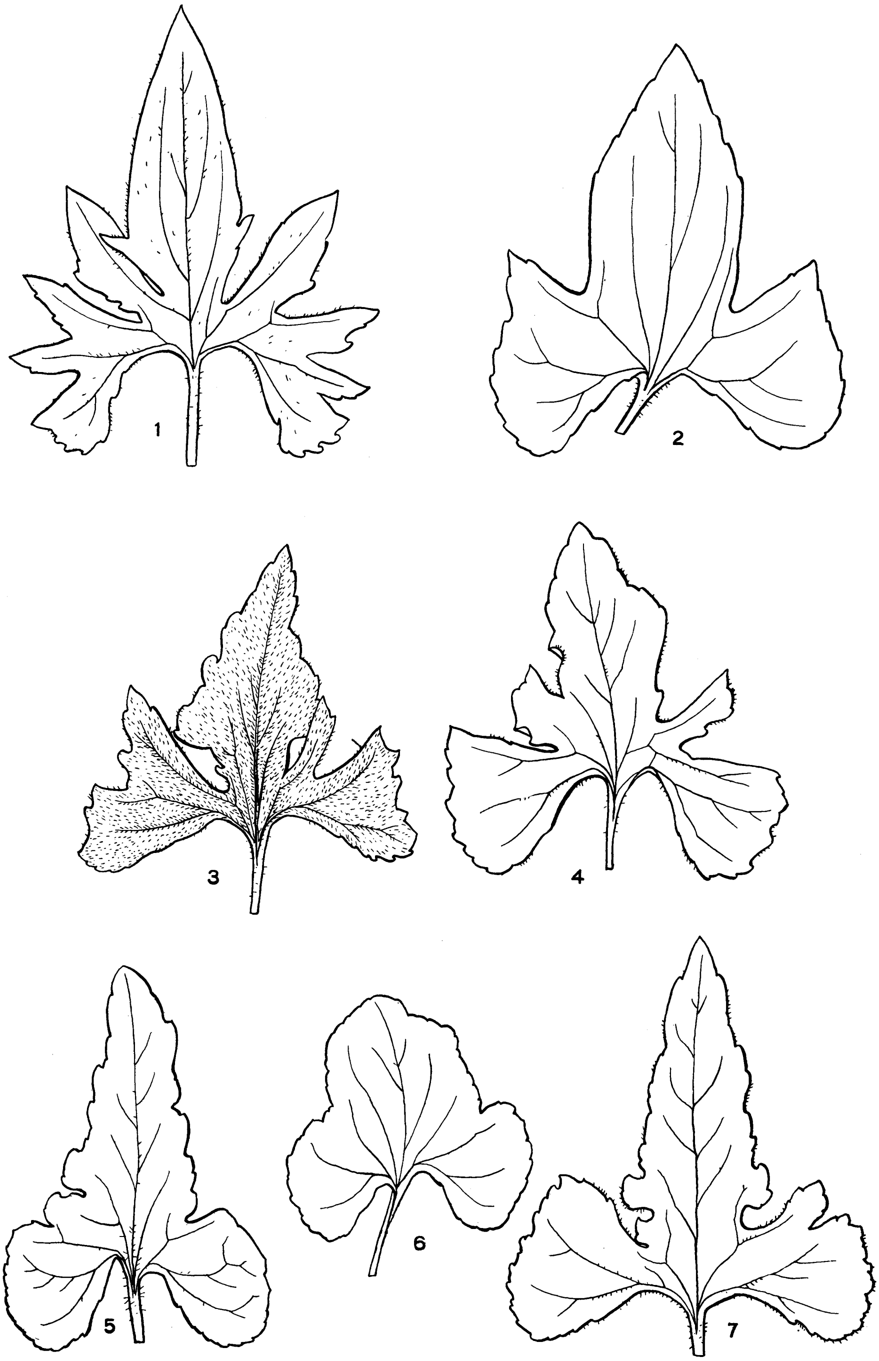
In two of the ten hybrids discussed in this paper, both parents are cut-leaved species: *V. palmata* × *triloba* and *V. Stoneana* × *triloba;* in the remaining eight the leaves of one parent are cut, of the other uncut. In all cases the leaf of the first hybrid (F_1) has an intermediate form. This rule regarding hybrid leaf form holds in all observed cases in the genus *Viola*. The same rule prevails to a large extent as regards pubescence; but here there are also cases of more or less complete dominance, as in *V. Stoneana* × *triloba*, where it is impracticable without an experimental test to distinguish among pubescent offspring which is stable



Viola palmata × papilionacea and leaves of the parent species



Three segregating offspring of Viola palmata × papilionacea



Leaves of Viola palmata × triloba and of its parents and its offspring and which unstable. Even in the character of seed color, or of capsule color, Mendelian dominance of brown over buff, or of purple over green, is usually somewhat imperfect; so that after some practice one can distinguish fairly well between pure and hybrid dominants. Details of this behavior will be given in a further paper, on the hybrids of *Viola pedatifida* of the Middle West.

MIDDLEBURY, VT.

Explanation of plates 5-7

PLATE 5

⅗ natural size

Aa. *Viola palmata* × *papilionacea* Brainerd, transplanted from Plainfield, N. J., June 1906; ex horto, Middlebury, Vt., Sept. 6, 1909.

A. Leaf of *Viola palmata* L., Yonkers, N. Y., Sept. 9, 1905.

a. Leaf of *Viola papilionacea* Pursh, Plainfield, N. J.

PLATE 6

⅔ natural size

Three offspring in third generation of *Viola palmata* × *papilionacea* shown in PLATE 5, *Aa;* grown from close-fertilized seeds of one plant. Ex horto, Oct. 2, 1909.

A. Reverting to *V. palmata* L.

a. Reverting to *V. papilionacea* Pursh.

Aa. Repeating hybrid leaf form.

PLATE 7

⅗ natural size

1. Leaf of *V. palmata* L., Orange, N. J.

2. Leaf of *V. triloba* Schwein., New Haven, Conn.

3 and 4. Two leaves, lower surface and upper, of *V. palmata* × *triloba*, transplanted from Maryland Heights, Md., May 1908; ex horto, May 31, 1911.

5–7. Three leaves of offspring of hybrid in third generation, grown from close-fertilized seeds of one plant.